106

106

STATE OF NEW YORK
HUGH L. CAREY, Governor

DEPARTMENT OF TRANSPORTATION
RAYMOND T. SCHULER, Commissioner

1220 WASHINGTON AVE., STATE CAMPUS, ALBANY, NEW YORK 12232

MEMBRANE WATERPROOFING APPLICATIONS IN NEW YORK

INTERIM REPORT

TECHNICAL REPORT 32

APRIL, 1977

materials
bureau
technical
services
subdivision

77-4

MEMBRANE WATERPROOFING APPLICATIONS IN NEW YORK

Interim Report

Conducted in Conjunction with
The U.S. Department of Transportation
Federal Highway Administration
National Experimental and Evaluation Program (NEEP) No. 12
Bridge Deck Protective Systems

prepared by
Robert J. Perry, Associate Civil Engineer (Materials)
Richard H. Frederick, Senior Civil Engineer (Materials)
David R. Brewster, Assistant Civil Engineer

April,1977
(Technical Report 32)

MATERIALS BUREAU, TECHNICAL SERVICES SUBDIVISION
New York State Department of Transportation
State Campus, Albany, New York 12232

ABSTRACT

Preformed sheet and liquid membrane waterproofing systems are being evaluated for use in concrete bridge deck rehabilitation work. The function of these membranes is to reduce the corrosion of reinforcement steel by providing a waterproof barrier between an existing concrete deck and a bituminous concrete overlay wearing surface.

This report describes the installation of five membrane systems. Three of these are proprietary preformed sheets (Heavy Duty Bituthene; Royston Bridge Membrane No. 10, and Protecto-Wrap M-400A); one is a proprietary liquid system (NEA-4000 LT); and one is a non-proprietary bituminous epoxy membrane waterproofing. Each of these membranes has been installed on a test structure and overlaid with a 2-1/2 inch thick bituminous wearing course.

No problems were encountered in the installation or overlaying of the waterproofing systems. To protect against damage from puncturing the preformed sheet systems were first paved with a bituminous mix having a maximum aggregate size of about 3/8 inch. Based on electrical resistance measurements (greater than 500 kil-ohms-s.f.) that were taken on the surface of the completed overlay, all of the membranes, except for the bituminous epoxy system, were performing satisfactorily at the time of installation. On the basis of the resistance test the initial impermeability of the bituminous epoxy membrane is questionable.

NYSDOT
Library
50 Wolf Road, POD 34
Albany, New York 12232

CONTENTS

		Page
I.	INTRODUCTION	1
	Background	1
	Purpose and Scope	1
II.	MEMBRANE WATERPROOFING MATERIALS	3
	Heavy Duty Bituthene	3
	Protecto-Wrap M-400A	3
	Royston Bridge Membrane No. 10	3
	NEA 4000 LT, (Low Temperature)	3
	Bituminous Epoxy (Two Coat Application)	4
III.	TEST SITES AND MEMBRANE INSTALLATIONS	5
	General	5
	Heavy Duty Bituthene	5
	Protecto-Wrap M-400A	8
	Royston Bridge Membrane No. 10	11
	NEA-4000 LT, (Low Temperature)	14
	Bituminous Epoxy (Two Coat Application)	18
IV.	SUMMARY OF MEMBRANE WATERPROOFING INSTALLATION DATA	21
	APPENDIX A: Specifications for Heavy Duty Bituthene Membrane Waterproofing	23
	APPENDIX B: Specifications for Protecto-Wrap M-400A Membrane Waterproofing	31
	APPENDIX C: Specifications for Royston Bridge Membrane No. 10	37
	APPENDIX D: Specifications for NEA-4000 LT, Membrane Waterproofing	43
	APPENDIX E: Specifications for Bituminous Epoxy Membrane Waterproofing	49

I. INTRODUCTION

Background

Bridge deck deterioration is recognized as a serious problem in New York. Although other factors contribute the major cause of deterioration is due to chloride ions from de-icing salts, which penetrate the concrete and cause corrosion of the reinforcing steel.

Normally steel reinforcement bars react with the atmosphere, or with wet concrete to form a thin protective oxide film. This film can protect (or delay) the steel from further corrosive attack and is said to render the steel "passive." When chloride ions from de-icing salts enter the concrete the protective oxide film is disrupted, the surface of the reinforcing steel becomes depassivated and the electrolytic conductivity of the concrete deck is increased. Under these conditions the corrosion of the steel reinforcing proceeds at an accelerated rate. The corrosion product (rust) that is formed is five to ten times as voluminous as the original material. This increased volume of the reinforcing bar creates tensile stresses within the concrete which eventually result in cracking, spalling and deterioration of the bridge deck.

Waterproofing membranes are proposed as a solution to the bridge deck deterioration problem. By providing an impermeable barrier they are designed to prevent the intrusion of chlorides and moisture into the concrete deck. In New York, membranes are considered for use only in rehabilitation work (maintenance and repair). For new construction, or complete deck replacement, the current practice is to construct the structural deck and wearing surface monolithically, using epoxy coated reinforcing bars in the top mat.

Purpose and Scope

This study is being conducted in conjunction with National Experimental Evaluation Program (NEEP) No. 12, Bridge Deck Protective Systems. The purpose of this program is to evaluate membrane waterproofing systems for use in concrete bridge deck maintenance (repair) work. The membranes in this evaluation are preformed sheets or liquid systems, that are placed as a waterproof barrier between an existing concrete deck and a bituminous concrete overlay wearing surface. The impermeable concrete overlays (Dow SM-100; Iowa and Polymer concretes, etc.) which act integrally as a waterproofing and overlay are being evaluated by the Department in separate studies.

This report describes the installation of five membrane systems. No laboratory work is associated with the evaluation. Three of the membrane systems are preformed sheets that have been designated as non-experimental by the Federal Highway Administration (Bituthene, Royston and Protecto-Wrap). A variation to the FHWA approved requirements is that no protective course (e.g. 65 lb. roofing paper) has been used. In lieu of this, to prevent damage in overlay operations, the maximum aggregate size in the bituminous mix is limited to 3/8 inch. The other two membranes are liquid systems. The first in an experimental, low temperature PVC polymer. This system is marketed on the East coast by POSH Chemical, Inc. as NEA-4000 LT and is comparable to Superseal 4000 LT. The second liquid is a two-coat epoxy membrane system. Bituminous epoxy has been used historically as a one-coat application in New York, but its performance has not been thoroughly documented.

II. MEMBRANE WATERPROOFING MATERIALS

Heavy Duty Bituthene

Heavy Duty Bituthene is a preformed sheet membrane. The preforemd sheet is 65 mils thick and composed of a woven polyethylene mesh, coated on one side with a layer of rubberized aspahlt. Bituthene Primer and Bituthene Mastic are used in conjunction with the installation. All materials are manufactured by W. R. Grace & Co., Cambridge, Mass. The contract specifications for Bituthene Waterproofing are in Appendix A.

Protecto-Wrap M-400A

Protecto-Wrap M-400A is a preformed sheet membrane, 70±5 mils thick. The preformed sheet is described as being a laminate of aromatic tars, modified with synthetic resins, and reinforced with a synthetic non-woven fabric. Protecto-Wrap #80 Primer and 160H Mastic (or Protecto-Wraps equivalents) are used in the installation. All materials are manufactured by the Protecto-Wrap Co., Denver, Colorado. The specifications for this system are in Appendix B.

Royston Bridge Membrane No. 10

Royston Bridge Membrane No. 10 is a preformed sheet, 75 mils thick. The preformed sheet is a laminate of reinforced fiberglass mesh and bituminous mastic with a top surface of polyester film. Royston Bridge Membrane Primer 713 and Royston Roskote A-51 Black Mastic are used in the installation. All materials are manufactured by Royston Laboratories, Inc., Pittsburgh, Pa. The specifications for this system are in Appencix C.

NEA-4000 LT, (Low Temperature)

NEA-4000 LT, is a liquid poly-vinyl chloride polymer waterproofing. It is hot applied at application temperatures of from 275-300°F., and at the rate of about 18 s.f./gal. (90 mils). A protective sheet of 65 lb. roofing paper is included in the system to prevent damage in bituminous overlay operations. NEA-4000 LT, is manufactured by POSH Chemical, Inc., Port Washington, N.Y. This liquid system is similar to Superseal-4000 LT (Superior Products Co., Oakland, CA) and WABO-4000LT (Watson-Bowman Associates, Inc., Buffalo, NY). The contract specifications for this system are in Appendix D.

Bituminous Epoxy (Two Coat Application)

The bituminous epoxy membrane is a non-proprietary liquid waterproofing system. It consists of a two-component, bituminous modified epoxy resin, applied in two coats (total thichness approximately 100 mils). Stone aggregate is spread in the second coat for adhesion to the bituminous overlay. New York's Standard Specifications for the two-component bituminous epoxy material and the membrane waterproofing system are in Appendix E.

III. TEST SITES AND MEMBRANE INSTALLATIONS

General

To evaluate membrane waterproofings, each of the five systems has been installed on a test structure. The observations and measurements that were recorded at the time of installation are the subject of this report. Future evaluations will report on the in-service performance of each membrane system.

For the purpose of recording resistance and corrosion potential data, each test structure has been instrumented. The instrumentation consists of a wired "ground" connection to each of 4 longitudinal and 4 transverse reinforcing bars in the top mat; and moisture-temperature sensing devices that are embedded in the concrete at the top level of steel reinforcement (Soiltest MC-363 Moisture-Temperature Cells: Soiltest, Inc., 2205 Lee Street, Evanston, Illinois 60602). The wired connections and sensing devices are terminated in a junction box and are available for use in each evaluation.

Heavy Duty Bituthene

1. Test Site

   Heavy Duty Bituthene was installed in conjunction with Contract FARC 74-45, Corning Area Bridge Reconstruction; Federal Aid Project Number U-225(46). The bridge is located approximately two miles west of the City of Corning, N.Y., and carries U.S. Rte. 15 (N.Y. RTE. 17) over the Erie-Lackawanna Railroad. Bridge deck work consisted of repairs to the existing structural slab; installation of Bituthene waterproofing; and placement of a 2½" thick bituminous overlay. Figure 1 shows details of this structure. Spans 1 and 2, Northbound, have been instrumented and will be used as the basis for the Bituthene evaluation.

2. Installation Cost of Bituthene Waterproofing

   Quantity = 21785 s.f. (2420 s.y.)
   Installed Cost = $0.50/s.f. ($4.50/s.y.)

3. Condition of Concrete Structural Deck

   a) Surface Texture: smooth, some uneveness; no surface projections greater than ¼"; scaled and raveled areas in existing deck were leveled with epoxy mortar.

   b) Cracks: None.

Bridge Identification Number (BIN): 1011200

Type of Structure: 3 span, simple, twin structure

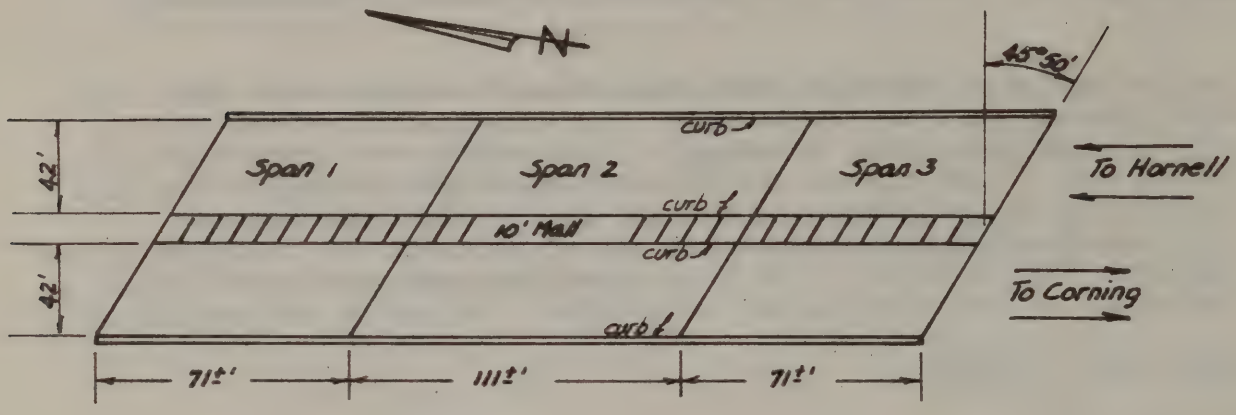
Span Lengths: 71'; 111'; 71'

Curb to Curb Width: 42' northbound; 42' southbound

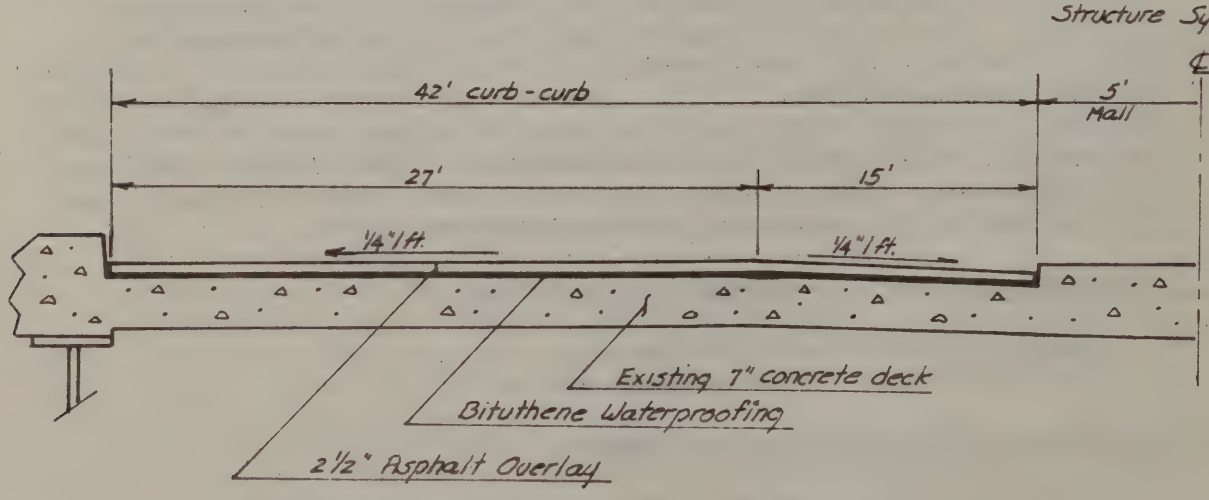
Skew Angle: 45°50'

Grade: approximately level (0%)

Instrumentation: Spans 1 and 2, Northbound



DECK PLAN



TRANSVERSE SECTION

Figure 1 - Test Structure For Heavy Duty Bituthene

c) Surface Preparation: concrete deck was sandblasted and blown clean with compressed air.

d) Depth of Concrete Cover over Top Mat of Steel Reinforcement: 1 inch.

e) Chloride Content of Existing Concrete Deck:

Span No.	Sample Depth	No. of Samples	Avg. Chloride Content (lbs. Cl^-/c.y.)
1 NB	3/4 - 1-1/4"	2	4.8
	1-3/4 - 2-1/4"	1	1.0
2 NB	3/4 - 1-1/4"	3	3.6
	1-3/4 - 2-1/4"	3	2.2
	2-3/4 - 3-1/4"	3	2.5

f) Corrosion Potential of Existing Concrete Deck (Cu-CuSO4 reference electrode):

Span No.	Mean Corr. Pote. (volts)	Std. Dev.	Minimun Corr. Pote. (volts)	Maximum Corr. Pote. (volts)	Number of Measurements (n)
1 NB	0.2726	0.0771	0.11	0.40	50
2 NB	0.1414	0.1040	0.00	0.43	87

g) Electrical Resistance (D.C.) of Concrete Deck:

2000-3000 ohm.-s.f. (range of 4 measurements on each span)

4. Installation of Heavy Duty Bituthene Waterproofing Membrane

The installation of Heavy Duty Bituthene was completed in two construction stages; half of the membrane was placed in September and the other half in October, 1976. No difficulties were encountered with the placement of Bituthene waterproofing and the work was performed in accordance with the specifications (Appendix A).

Bituthene primer was "painted" on the deck and vertical surfaces with rollers. The primer dried within 1/2 hour and no bubbles from out-gassing were visible. "Flashing strips" of membrane were placed up the vertical faces of curbs and headers and their termination edges sealed with Bituthene Mastic. Rolls of preformed membrane sheet were then applied to the deck using stiff brooms to provide contact and eliminate air pockets. The applied membrane was then hand rolled with a 100-200 pound roller. The completed membrane showed no visual defects. Some air bubbles were noted on the day of application, but, due to cooler night temperatures (in-gassing of the deck) these bubbles had disappeared the following morning when the deck was paved.

Electrical resistance measurements were recorded at random points on the surface of the membrane sheet (35 points on Span 1 NB; 55 points on Span 2 NB). All of the measurements were equal to infinity (∞). By accepted standards* this indicates that the membrane was waterproof before the placement of the bituminous overlay.

5. Overlaying Heavy Duty Bituthene

The Bituthene waterproofing system was paved with a 2-1/2 inch thick bituminous overlay. The first course was placed 1 inch thick and within a paving temperature range of 250°-300°F. To prevent damage from puncturing, the first course was specified as Type 1A Top, with a maximum aggregate size of about 3/8 inch. The second course was Type 1 AF Top (High Friction) placed 1-1/2 inch thick. No problems or damage to the membrane occurred in paving operations.

Electrical resistance measurements were taken on the completed overlay and the results are summarized below. The data indicates that the Bituthene waterproofing was not damaged in paving operations and was performing satisfactorily at the time of installation. The 7 values that were recorded below the 500 kil-ohm limit were all located near weeps, or at the curb, and rain the previous night is a probable cause of these lower measurements.

Measurement Range (kil-ohm-s.f.)	Number of Recorded Values Span 1 NB	Span 2 NB
less than 100	0	1
100-500	1	5
greater than 500	44	55

Protecto-Wrap M-400A

1. Test Site

Protecto-Wrap M400A was installed in conjunction with Contract FARC 75-176, Waverly Area Bridge Rehabilitation; Federal Aid Project Number U-995(5). The bridge is located approximately 1-1/4 miles north of the Village of Waverly, N.Y. and carries N.Y. Rte. 34 over Cayuta Creek. Bridge deck work consisted of replacing the existing deck with a new 9-inch thick concrete structural slab; installation of Protecto-Wrap M-400A waterproofing; and placement of a 2-1/2" thick bituminous overlay. Figure 2 shows details of this bridge.

* Testing on waterproofing membranes has resulted in the following interpretation of Electrical Resistance measurement values:

Greater than 500 kil-ohms-s.f. = acceptable performance
Less than 100 kil-ohms-s.f. = unacceptable performance
Between 100-500 kil-ohms-s.f. = inconclusive performance.

2. Installation Cost of Protecto-Wrap M-400A Waterproofing

Quantity = 5,641 s.f. (627 s.y.)
Installed Cost = $0.50/s.f. ($4.50/s.y.)

3. Condition of Concrete Structural Deck

a) Surface Texture: new concrete deck was finished smooth with no evidence of surface projections.

b) Cracks: none.

c) Surface Preparation: concrete deck was blown clean with compressed air.

d) Depth of Concrete Cover over Top Mat of Steel Reinforcement: 1 inch.

e) Chloride Content of New Concrete Deck

Sample Depth	No. of Samples	Avg. Chloride Content (lbs. Cl^-/c.y.)
3/4-1-1/4"	6	0.3
1-3/4-2-1/4"	6	0.3
203/4-3-1/4"	6	0.4

f) Corrosion Potential of New Concrete Deck (Cu-CuSO4 reference electrode):

Mean Corr. Pote. (volts)	St'd. Dev.	Minimum Corr. Pote. (volts)	Maximum Corr. Pote. (volts)	Number of Measurements
0.2598	0.0251	0.20	0.33	261

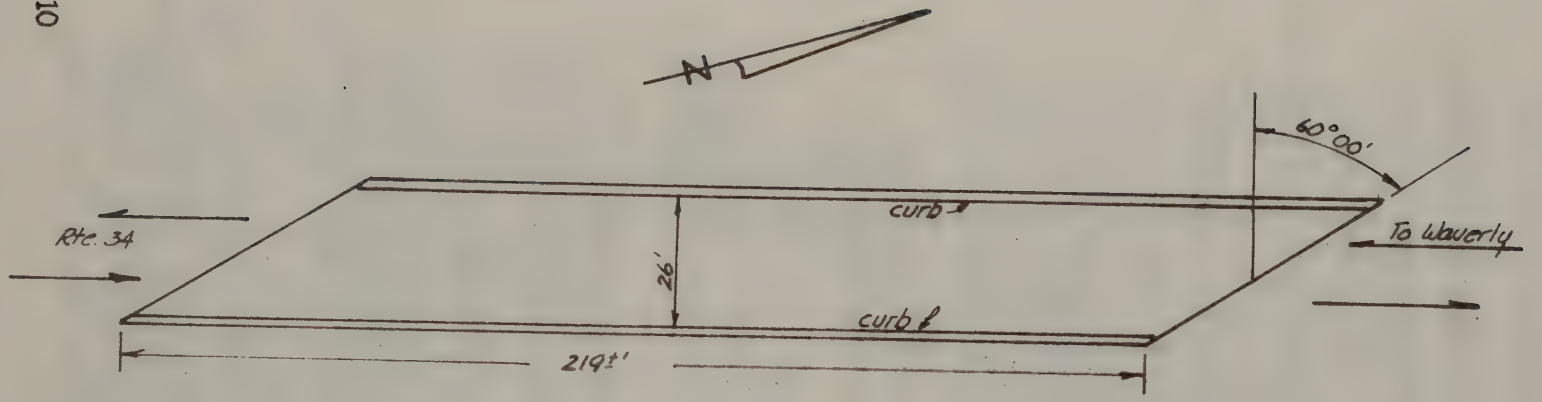
g) Electrical Resistance (D.C.) of Exposed Concrete Deck

2000-3000 ohms-s.f. (range of 8 measurements)

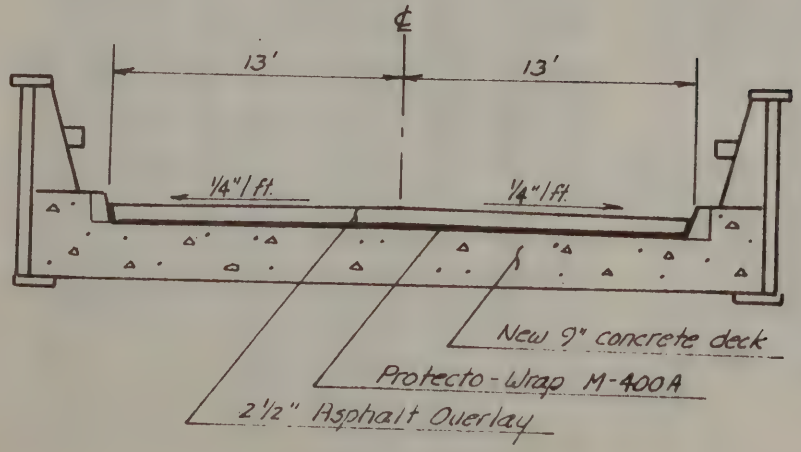
4. Installation of Protecto-Wrap M-400A Waterproofing Membrane

The installation of Protecto-Wrap M-400A was completed in two construction stages; the membrane was placed in the Northbound lane in June and in the Southbound lane in August, 1976. No problems were encountered with its installation and the work was performed in accordance with the specifications (Appendix B).

Protecto-Wrap No. 80 Primer was applied to the deck and vertical faces, using rollers. The primer dried to a tack free condition within 1/2 hour. Bubbles (1/8 to 1/4 " dia.) from outgassing of the deck developed in the primer. In the June application (air temp-85-95^{o}F.), bubble density was recorded at 150-250/s.f.; in August when it was cooler (60-70^{o}F.) the bubble density decreased to about 10/s.f. The bubbles



DECK PLAN



TRANSVERSE SECTION

Bridge Identification Number (BIN): 1023170

Type of Structure: Through Girder, Single Span, continuous

Span Length: 219 ± '

Curb to Curb Width: 26 ± '

Skew Angle: 60°00'

Grade: 4%

Figure 2 - Test Structure For Protecto-Wrap M-400A

were broken with a stiff bristled broom before the membrane was applied. Rolls of preformed membrane sheet were then placed on the deck and up the vertical faces of curbs and headers. The rolls of membrane were placed on the deck using a stiff bristled broom to provide contact and eliminate air bubbles; the membrane was adhered to the vertical faces by first coating the face with 160 H Mastic and pressing the membrane into contact with this sealer. After application, the termination edges of the membrane were sealed with mastic and the applied waterproofing was rolled, using a pick-up truck. The completed membrane showed no visual defects.

Electrical resistance measurements were recorded at 70 random points on the surface of the membrane sheet. Sixty-seven (67) of the measured values were equal to infinity (∞); the remaining 3 measurements, all of which were located on a lapped joint, exceeded 1200 kil-ohms-s.f.

5. Overlaying Protecto-Wrap M-400A

The Protecto-Wrap waterproofing system was paved with a 2 1/2 inch thick bituminous overlay. The first course was placed 1 inch thick and within a paving temperature range of 275°-310°F. To prevent damage from puncturing, this mix was specified as Type 1A Top, with a maximum aggregate size of about 3/8 inch. The second course was Type 1AF Top (High Friction) placed 1 1/2 inch thick. No problems or damage to the membrane occurred in paving operations, despite the 4% grade on this structure.

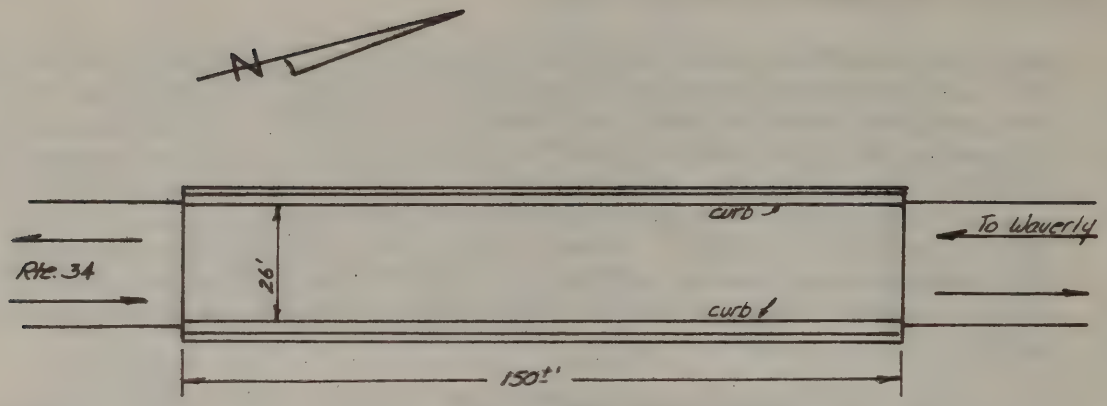
Electrical resistance measurements were taken at random points on the bituminous overlay. This data is summarized below. All of the measurements except for one, were recorded as greater than 500 kil-ohms-s.f. This indicates that the Protecto-Wrap M-400A was not damaged in overlay operations and was performing satisfactorily at the time of installation.

Measurement Range (kil-ohms-s.f.)	Numbers Of Recorded Values
less than 100	0
100 - 500	1
greater than 500	79

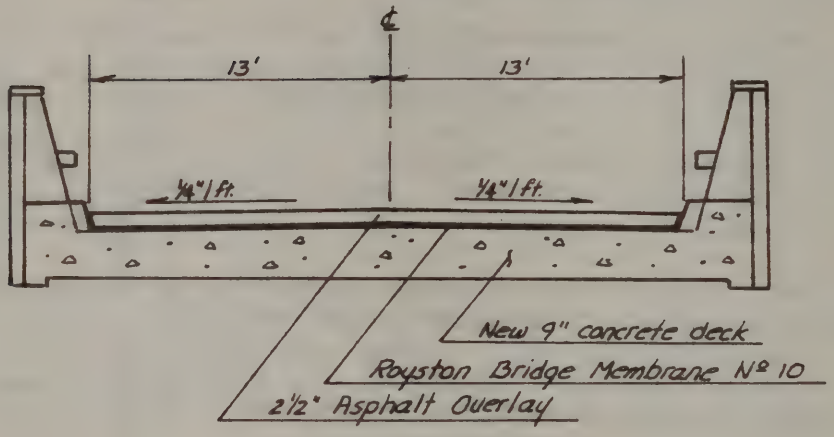
Royston Bridge Membrane No. 10

1. Test Site

Royston Bridge Membrane No. 10 was installed in conjunction with Contract FARC 75-176, Waverly Area Bridge Rehabilitation; Federal Aid Project Number U-995(5). The bridge is located approximately 1 1/4 miles north of the Village of Waverly, N.Y. and carries N.Y. Rte. 34 over the Lehigh Valley Railroad. Bridge deck work consisted of replacing the existing deck with a new 9-inch thick concrete structural slab; installation of Royston waterproofing; and placement of a 2 1/2 inch thick bituminous overlay. Figure 3 shows details of this bridge.



DECK PLAN



TRANSVERSE SECTION

Bridge Identification No. (BIN) - 1023180
Type of Structure - Through Girder, single span, continuous
Span Lenght - 150±'
Curb to Curb Width - 26±'
Skew Angle - 0°00'
Grade - 0.5% approximately level

Figure 3 - Test Structure For Royston Bridge Membrane No. 10

2. Installation Cost of Royston Bridge Membrane No. 10

Quantity = 3880 s.f. (431 s.y.)
Installed Cost = $0.50/s.f. ($4.50/s.y.)

3. Condition of Concrete Structural Deck

a) Surface Texture: new concrete deck was finished smooth with no evidence of surface projections.

b) Cracks: none.

c) Surface Preparation: concrete deck was blown clean with compressed air.

d) Depth of Concrete Cover over Top Mat of Steel Reinforcement
2 inches

e) Chloride Content of New Concrete Deck

Sample Depth	No. of Samples	Avg. Chloride Content (lbs. Cl^-/c.y.)
3/4-1 1/4"	6	0.3
1 3/4-2 1/4"	6	0.6
2 3/4-3 1/4"	6	0.6

f) Corrosion Potential of New Concrete Deck
(Cu-$CuSO_4$ reference electrode):

Mean Corr. Pote. (volts)	St'd. Dev.	Minimum Corr. Pote. (volts)	Maximum Corr. Pote. (volts)	Number of Measure-ments
0.2822	0.0365	0.20	0.36	174

g) Electrical Resistance (D.C.) of Exposed Concrete Deck

2000-3000 ohms-s.f. (range of 8 measurements)

4. Installation of Royston Bridge Membrane No. 10

The installation of the Royston waterproofing membrane was completed in two construction stages; the membrane was placed in the Southbound lane in June and in the Northbound lane in August, 1976. The membrane was placed without difficulty and in accordance with the specifications (Appendix C.).

Royston Primer 713 was applied to the deck and vertical faces with rollers. The primer dried to a tack-free condition within 1/2 hour. Bubbles of from 1/8-1/4" diameter developed in the primer. Bubble density ranged from 150-250/s.f. in the June installation (85-95^{o}F) to

only localized occurances in August when the weather was cooler (60-70°F.). The bubbles were broken with a stiff bristled broom before the membrane was applied. Rolls of preformed membrane sheet were then placed on the deck and up the vertical faces of curbs and headers. The rolls of membrane were placed on the deck using a stiff bristled broom to provide contact and eliminate air bubbles. The membrane was adhered to vertical surfaces by a heat-fusion method; by heating the sticky side of the membrane with a propane torch and pressing the heated membrane into contact with the vertical face. After application, the termination edges of the membrane were sealed with mastic and the applied waterproofing was hand rolled with a 100-200 pound roller. In June, when the weather was hot, some air bubbles developed due to outgassing of the deck. Most of these had disappeared the following morning when the temperature was cooler and the deck was paved. The completed membrane showed no other visual defects.

Electrical resistance measurements were recorded at 57 random points on the surface of the membrane sheet. Fifty-six (56) of the measured values were equal to infinity (∞); 1 value equaled 4000 kil-ohm-s.f.

5. Overlaying Royston Bridge Membrane No. 10

The Royston membrane was paved with a 2 1/2 inch thick bituminous overlay. The first course was placed 1 inch thick and within a paving temperature range of 275°-310°F. To prevent damage from puncturing, this mix was specified as Type 1A Top, with a maximum appregate size of about 3/8 inch. The second course was Type 1AF Top (High Friction) placed 1 1/2 inch thick. No problems or damage to the membrane occurred in paving operations.

Electrical resistance measurements were taken at random points on the bituminous overlay. This data is summarized below. All of the measurements, except for five were recorded at greater than 500 kil-ohms. These five values were recorded in a low area and rain the previous night probably influenced these measurements. In general the resistance data indicates that the Royston membrane was not damaged in overlay operations and was performing satisfactorily at the time of installation.

Measurement Range (kil-ohms-s.f.)	Number of Recorded Values
less than 100	1
100-500	4
greater than 500	55

NEA 4000 LT (Low Temperature)

1. Test Site

NEA-4000 LT, liquid waterproofing membrane was installed in conjunction with Contract FARC 75-45, Corning Area Bridge Reconstruction; Federal Aid Project Number U593 (16). The bridge is located at Painted Post,

N.Y. and approximately 1 mile west of the City of Corning. The structure carries U.S. Rte 15 over the Cohocton River. Bridge deck work consisted of repairs to the existing structural slab; installation of NEA-4000 LT, waterproofing; and the placement of a 2 1/2" thick bituminous overlay. Figure 4 shows the details of this structure. Spans 2 and 5, in the Southbound lanes are instrumented and will be used as the basis for the NEA-4000 LT, evaluation.

2. Installation Cost of NEA-4000LT Waterproofing

Quantity = 30,292 s.f. (3366/s.y.)
Installed Cost = $0.50/s.f. ($4.50/s.y.)

3. Condition of Concrete Structural Deck

a) Surface Texture: smooth, some uneveness; no surface projections greater than 1/4"; sealed and raveled areas in existing deck were leveled with epoxy mortar.

b) Cracks: none.

c) Surface Preparation: concrete deck was sandblasted and blown clean with compressed air.

d) Depth of Concrete Cover over Top Mat of Steel Reinforcement: 1 inch

e) Chloride Content of Existing Concrete Deck

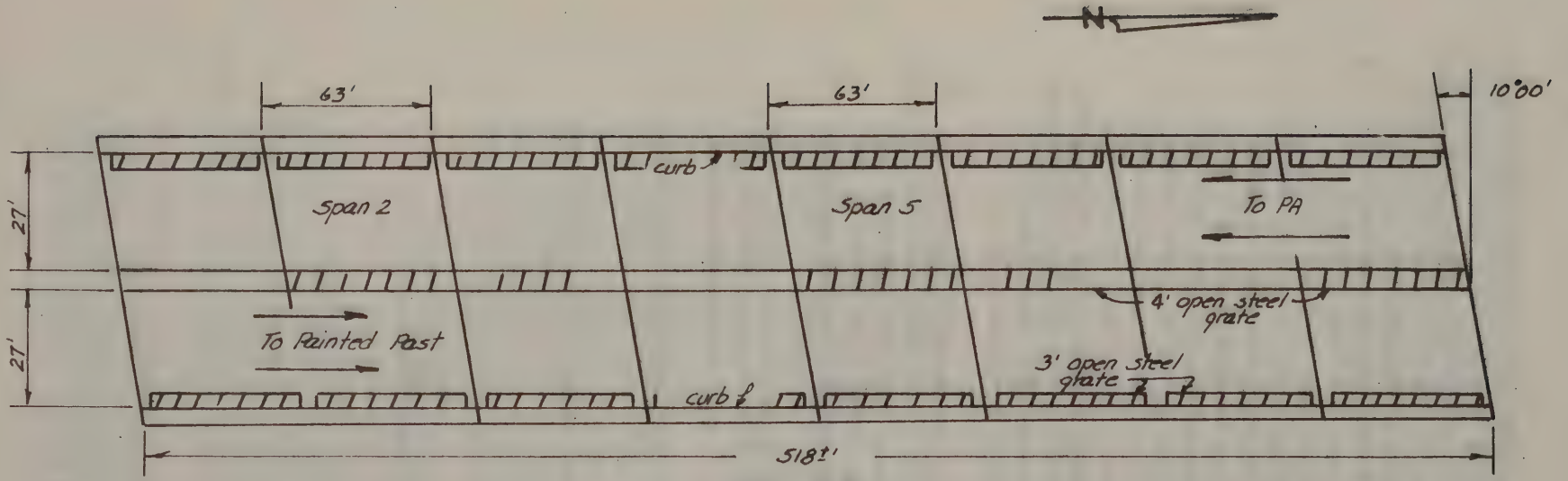
Span No.	Sample Depth	Number of Samples	Avg. Chloride Content (lbs. Cl^-/c.y.)
2- S.B.	3/4-1 1/4"	3	3.2
	1 3/4-2 1/4"	3	1.2
	2 3/4-3 1/4"	3	0.5
5-S.B.	3/4-1 1/4"	3	1.8
	1 3/4-2 1/4"	3	0.4
	2 3/4-3 1/4"	3	0.3

f) Corrosion Potential of Existing Concrete Deck ($CU-CUSO_4$ reference electrode):

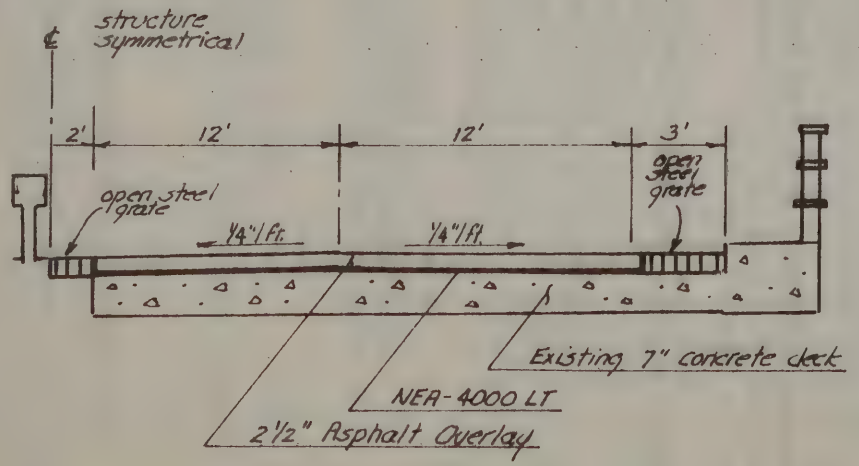
Span No.	Mean Corr. Pote. (volts)	Standard Deviation	Minimum Corr. Pote. (volts)	Maximum Corr. Pote. (volts)	No. of Measure-ments
2 S.B.	0.2279	0.0565	0.11	0.35	56
5 S.B.	0.2317	0.0739	0.11	0.47	47

g) Electrical Resistance (D.C.)of Exposed Concrete Deck

3000-6000 ohms-s.f. (range of 8 measurements, on each of Spans 2 and 5)



DECK PLAN



TRANSVERSE SECTION

Bridge Identification Number (BIN)-1101160

Type of Structure - 8 span, simple

Span Lengths - 63±' each (approximate)

Curb to Curb Width - 58±' (Southbound-29±')
(Northbound-29±')

Skew Angle - 10°00'

Grade - approximately level (0%)

Instrumentation - Spans 2 and 5, Southbound

Figure 4 - NEA-4000 LT Test Structure

4. Installation of NEA-4000 LT Waterproofing Membrane

The installation of NEA-4000 LT was completed in two construction stages; half the membrane was placed in August and the remainder in October, 1976. NEA-4000 LT was installed without difficulty and in accordance with the contract specifications (Appendix D). The liquid membrane material was first heated in 275-300°F, in special applicating equipment; the hot liquid was then pumped onto the deck and spread onto the horizontal and vertical surfaces with squeegees. Some minor bubbling occurred in the material as it cured to a tacky condition. On the advice of the manufacturer, the 65# roofing paper protective course was placed directly onto the wet surface of the liquid membrane. This procedure eliminated the need for bursting the bubbles and was satisfactory from the standpoint of applying and adhering the roofing to the membrane surface. After curing, the liquid membrane showed good adhesion to the concrete deck and overlying roofing paper protective course.

Electrical resistance measurements were recorded on the surface of the protective sheet. On Span 2 SB, 36 points were measured; 34 of these measurements were equal to infinity (∞); one was recorded at 250 kil-ohm-s.f. and one at 300 kil-ohm-s.f. Thirty-one (31) measurements were recorded on Span 5 SB; 30 equaled infinity (∞) and one equaled 1600 kil-ohm-s.f.

5. Overlaying NEA-4000 LT

NEA-4000 was paved with a 2 1/2 inch thick bituminous overlay. To prevent damage to the membrane, the maximum paving temperature of the asphalt mix was limited to 300°F. There were no problems except in one small area where "shoving" occurred, when a roller operator came to an abrupt stop. The asphalt was removed and replaced in this location (5'x10' section).

Electrical resistance measurements were taken on the completed overlay. This data is summarized below. On Span 2 SB, all of the values except for two were recorded at infinity (∞). The two low values (110 & 33 kil-ohms) were measured over weeps in the deck. The previous day's rain is the probable reason for the low measurements. On Span 5 SB, all of the values were also equal to infinity (∞), except for two. Both of the lower readings (380 & 480 kil-ohms) were located in the area that was damaged in paving operations. In general, the resistance data shows that the NEA-4000 LT membrane was not damaged in paving, and was performing satisfactorily at the time of installation.

Measurement Range (kil-ohm-s.f.)	Number of Recorded Values Span 2 SB	Span 5 SB
Less than 100	1	0
100-500	1	2
greater than 500	60	63

Bituminous Epoxy (Two Coat Application)

1. Test Site

The bituminous epoxy liquid waterproofing membrane was installed in conjunction with Contract M75-3, Rehabilitation of the Delaware Avenue Bridge. This structure is located in the Cities of Tonowanda and North Tonowanda, N.Y. and carries Delaware Avenue over the Erie Canal. Bridge deck work consisted of repairs to the existing structural slab; the installation of the bituminous epoxy waterproofing (on 2 of the 3 spans); and the placement of a 2 1/2" thick bituminous overlay. One span on the bridge was not waterproofed because of its severe grade (5 1/2%). This section will be evaluated as a control. Figure 5 shows the details of this structure.

2. Installation Cost of Bituminous Epoxy (Two Coat Application)

Quantity = 8000 s.f. (889 s.y.)
Installed Cost = $2.65/s.f. ($23.85 s.y.)

3. Condition of Concrete Structural Deck

a) Surface Texture: smooth, some uneveness; no surface projections greater than 1/4"; scaled and raveled areas in existing deck were leveled with epoxy mortar.

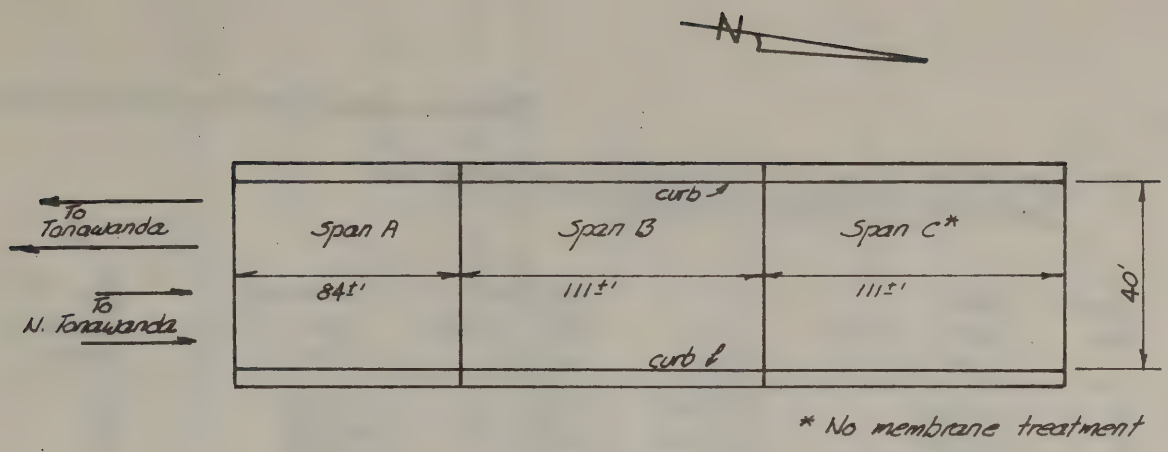
b) Cracks: a single transverse crack extended full width across the deck over each floor beam (floor beams = 14± c. to c.). The crack width varied from "hairline" to 1/32". There were no other defects.

c) Surface Preparation: concrete deck was blown clean with compressed air.

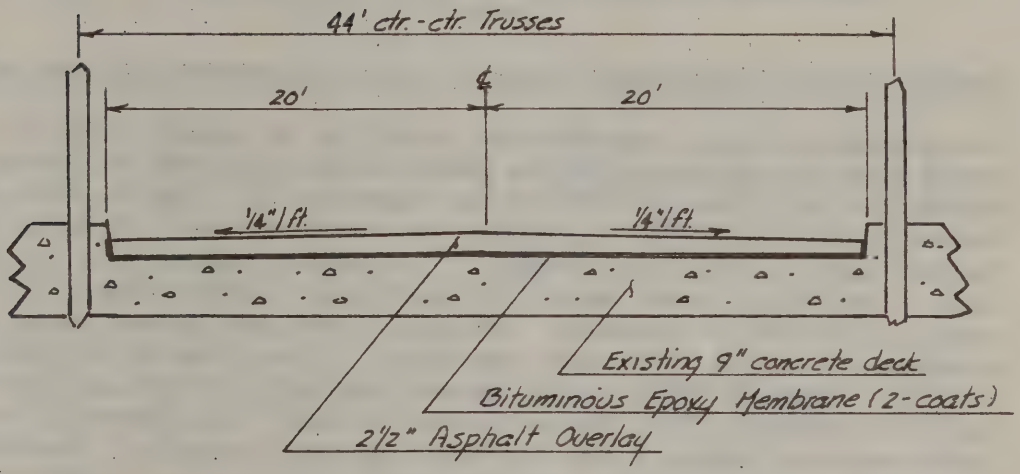
d) Depth of Concrete Cover over Top Mat of Steel Reinforcement: 2 1/2-3 inch.

e) Chloride Content of Existing Concrete Deck

Span No.	Sample Depth	No. of Samples	Avg. Chloride Content (lbs. Cl^-/c.y.)
A	3/4-1 1/4"	4	3.2
	1 3/4-2 1/4"	4	1.7
	2 3/4-3 1/4"	4	1.2
B	3/4-1 1/4"	4	3.6
	1 3/4-2 1/4"	4	2.2
	2 3/4-3 1/4"	4	1.3
C	3/4-1 1/4"	4	2.9
	1 3/4-2 1/4"	4	1.8
	2 3/4-3 1/4"	4	1.2



DECK PLAN



TRANSVERSE SECTION

Bridge Identification No. (BIN)-4453030

Type of Structure - 3 span, simple, truss

Span Lengths - 84±'; 111±'; 111±'

Curb to Curb Width - 40±'

Skew Angle - 0°00'

Grade - Span A: % (level)
Span B: -3%
Span C: -5.5%

Figure 5 - Bituminous Epoxy (2 Coat Application) Test Structure

f) Corrosion Potential of Existing Concrete Deck (Cu-$CuSO_4$ reference electrode):

Span No.	Mean Corr. Pote. (volts)	Std. Dev.	Minimum Corr. Pote. (volts)	Maximum Corr. Pote. (volts)	No. of Measure-ments
A	0.2519	0.1000	0.09	0.51	72
B	0.1907	0.1085	0.02	0.52	90
C	0.2419	0.0987	0.07	0.55	90

g) Electrical Resistance (D.C.) of Exposed Concrete Deck

2000-4000 ohms-s.f. (range of 4 measurements on each of Spans A, B, & C.)

4. Installation of Bituminous Epoxy (2 Coats) Waterproofing Membrane

The bituminous epoxy membrane was installed in August, 1976. In general there were no problems with the installation and work was performed in accordance with the specifications (Appendix E). The liquid epoxy was spread on the deck with squeegees; the vertical faces of curbs and headers were coated using brushes. Outgassing was visible in the first coat. Typically, there were 6-10 bubbles/s.i. (800-1500/s.f.), approximately 1/16-1/8" in diameter. These bubbles were broken, using a squeegee after the first coat had cured. (cure time of 2-3 hours; temperature range 50-69°F.). The second coat was applied and stone aggregate was broadcast into the wet epoxy,by hand. The aggregate distribution was satisfactory and the stone was well embedded. Bubbles did not occur with the second coat and the completed membrane showed no visual signs of voids or defects.

No resistance measurements were recorded on the surface of the membrane.

5. Overlaying Bituminous Epoxy Waterproofing Membrane

The bituminous epoxy membrane was paved with a 2 1/2 inch thick bituminous overlay. No incidents occurred.

Electrical resistance measurements were taken on the completed overlay and are summarized below. Based on the number of measurements that were recorded below the 500 kil-ohm threshold, the effectiveness of the epoxy membrane at the time of its installation is questionable. In fact, the resistance values on Span C where there is no membrane treatment, are comparable to those on Spans A and B.

Measurement Range (kil-ohm-s.f.)	Number of Recorded Values Span A	Span B	Span C
less than 100	8	11	10
100-500	6	6	6
greater than 500	6	3	4

IV SUMMARY OF MEMBRANE WATERPROOFING INSTALLATION DATA

	HEAVY DUTY BITUTHENE		PROTECTO-WRAP	ROYSTON	NEA-4000 LT		BITUMINOUS EPOXY (2 coats)		
	Span 1 NB	Span 2 NB	M-400 A	MEMB. NO 10	Span 2 SB	Span 5 SB	Span A	Span B	*Span C
1. CONCRETE STRUCTURAL DECK									
Type of Deck	Old (Existing)		New	New	Old (Existing)		Old (Existing)		
-Chloride Content (lbs.Cl^-/c.y.)									
1" depth	4.8	3.6	0.3	0.3	3.2	1.8	3.2	3.6	2.9
2" depth	1.0	2.2	0.3	0.6	1.2	0.4	1.7	2.2	1.8
3" depth	-	2.5	0.4	0.6	0.5	0.3	1.2	1.3	1.2
-Corrosion Potential (CSE)	0.27v.	0.14v.	0.26v.	0.28v.	0.23v.	0.23v.	0.25v.	0.19v.	0.24v.
- Electrical Resistance (kil-ohms-s.f.)	0.2-0.3	0.2-0.3	0.2-0.3	0.2-0.3	0.3-0.6	0.3-0.6	0.2-0.4	0.2-0.4	0.2-0.4
2. MEMBRANE WATERPROOFING									
-Application Problems.	none	none	none	none	none	none	none	none	*
-Electrical Resistance (before overlay)									
Total Number of Measurements:	35	55	70	57	36	31	**	**	*
100 kil-ohm-s.f.	0	0	0	0	0	0			
100-500 kil-ohm-s.f.	0	0	0	0	2	0			
500 kil-ohm-s.f.	35	55	70	57	34	31			
3. BITUMINOUS OVERLAY									
-Paving Problems	none	none	none	none	none	none	none	none	none
Electrical Resistance (after overlay)									
Total Number of Measurements:	45	61	80	60	62	65	20	20	20
<100 kil-ohm-s.f.	0	1	0	1	1	0	8	11	10
100-500 kil-ohm-s.f.	1	5	1	4	1	2	6	6	6
>500 kil-ohm-s.f.	44	55	79	55	60	63	6	3	4
4. INSTALLATION COST ($/s.y.)- not including pavement	$4.50	$4.50	$4.50	$4.50	$4.50	$4.50	$23.85	$23.85	*0

* No. Membrane Treatment
** Data not available

APPENDIX A

SPECIFICATIONS FOR HEAVY DUTY BITUTHENE MEMBRANE WATERPROOFING

ITEM BRIDGE PREFORMED MEMBRANE WATERPROOFING SYSTEM (HEAVY DUTY BITUTHENE)

SCOPE:

The work shall consist of furnishing and applying a preformed membrane waterproofing system. It shall include, but not be limited to the preparation of concrete surfaces; the application of cold applied primer and preformed membrane as specified in the Contract Documents.

MATERIALS:

The preformed membrane waterproofing system shall be as manufactured by W. R. Grace & Company, Cambridge, Massachusetts, and shall consist of the following materials:

Bridge Preformed Membrane - Heavy Duty Bituthene

Primer - Bituthene Primer

Mastic Sealer - Bituthene Mastic

Wire mesh, for use over subdrainage openings, shall be a first class, 1/4-inch mesh by 23 gauge, hot-dipped galvanized cloth.

CONSTRUCTION DETAILS:

A. Preparation of Structural Slab Surfaces.

All structural slab surfaces that are to be waterproofed, including vertical surfaces, shall be prepared and cleaned as follows: Unless otherwise directed by the Engineer, work shall not begin on new structural slabs until a minimum of 28 days after concrete placement.

1. All loose material, including dirt, stones, gravel and concrete laitance shall be removed by vacuuming or blowing with compressed air.

2. Any excess laitance (surface film of concrete), road oil, other bituminous based contaminates, and other foreign materials, including concrete curing compounds, which are detrimental to membrane adhesion shall be removed by sandblasting or wire brushing and washing with water or a combination of these methods. To determine if adhesion problems exist, small test patches of primer and membrane, shall be applied to the area(s) in question. These test patches shall then be checked by the Engineer to determine the compatibility and adhesion of the membrane to the concrete surface.

3. All surface projections, including exposed aggregate or any other conditions which have presented so rough a concrete surface, as determined by the Engineer to be detrimental to the membrane, shall be ground smooth, or grouted smooth with cement mortar or epoxy. If grouting materials are used, they shall be "set up" and

surface dry, prior to application of primer. Cement mortar mixes for use in grouting shall be approved by the Engineer prior to use. Epoxy mortar materials shall consist of epoxy material meeting the requirements of Material Specifications 721-01, 721-02 or 721-03, and fine aggregate as approved by the Engineer.

4. Immediately prior to primer application, surfaces to be primed shall be re-cleaned of dust and other loose foreign material by vacuuming or blowing with compressed air.

B. Atmospheric Conditions.

Work shall not be done during wet weather conditions, nor when determined by the Engineer atmospheric conditions are such as to produce unsatisfactory results. No work shall be done when the structural slab surface temperature is below 40°F and ambient temperatures are below 40°F. The concrete structural slab shall be surface dry at the time of primer application.

C. Primer Application.

After cleaning, all concrete surfaces to be waterproofed shall be primed with Bituthene Primer. The primer shall be thoroughly mixed prior to use. Mixing shall be done with mechanical mixers or hand mixed, using clean paddles or other suitable instruments. All settled material shall be thoroughly dispersed.

The primer shall be applied, without dilution, by the use of brushes or rollers or a combination of these methods. Spray application of primer will not be allowed. The primer shall be applied at the rate of 200-400 square feet per gallon so as to thoroughly and uniformly cover the concrete surface. Areas of concrete which are porous, and appear dry, shall be given a second coat of primer.

On vertical curb and header surfaces, the primer shall be applied and finished off, in a neat line, to a height that will be one inch ± higher than the height of the completed asphalt overlay. The outside face of metal scuppers shall not be primed. The inside surfaces of subdrainage outlets (weep tubes) shall be primed to a depth of at least 3 inches.

The primer shall be allowed to dry to a "tack-free" condition prior to application of the preformed membrane. This time, which is dependent on temperature and humidity, is normally one hour. Excess primer, occurring as "puddles" or wet areas, shall be removed by brushes, or as directed by the Engineer.

Primed areas which have not been covered with preformed membrane within 36 hours after the application of primer, shall be re-primed.

Primed surfaces which, as determined by the Engineer, have become contaminated by dust and dirt shall be re-primed.

The appearance of bubbles in the primer is normal, due to out-gassing of air and moisture in the concrete. After the primer has dried to a "tack-free" condition, these bubbles shall be broken with squeegees or brooms. Unless otherwise directed by the Engineer, it shall not be necessary to repair the areas where bubbles have been broken.

D. Preformed Membrane Installation.

Heavy-duty bituthene preformed membrane shall be applied to primed surfaces no later than 36 hours after primer application.

Rolls of membrane may be applied by hand or mechanical means. The membrane shall be placed on the structural slab sticky side down, by removing the release paper as the work progresses. Preformed membrane flashing strips shall be placed and turned up the faces of curbs and headers and scuppers to a height equal to the thickness of bituminous overlay. Rolls of membrane shall be placed in such a manner as to minimize wrinkles and bubbles, but shall not be stretched or otherwise placed in tension. Squeegees shall be used, at the time of application, to smooth the membrane at its point of contact with the structural slab.

To insure adhesion to the structural slab, the preformed membrane shall be rolled with a pneumatic tired roller. Rolling shall be done at the end of each day's work, as applicable.

The preformed bridge membrane shall be laid longitudinally on the structural slab in the direction opposite to that of bituminous paving so that end laps are formed in the direction of bituminous paving. It shall be placed from a low to a high area and in such a manner as to produce a "shingling" effect to drain any water that accumulates toward the curb and scuppers. Adjacent rolls of membrane shall overlap a minimum of 2-1/2 inches and 8 inches on end laps. Laps which have not been thoroughly sealed by rolling operations shall be sealed with Bituthene Mastic Sealer.

The application of preformed membrane shall commence at the curb section(s). First, "flashing" strips, cut from rolls of preformed membrane, shall be applied on the curb face to a height equal to the depth of bituminous overlay. The strips shall extend a minimum of 6 inches on the structural slab and shall be thoroughly pressed into contact with the concrete surfaces.

On granite or other rough curb faces, beads of Bituthene Mastic shall be applied to the vertical face, to insure bonding of the flashing strips. The first full roll of preformed membrane sheet

shall then be aligned parallel to and applied on the structural slab as close as possible to the curb face. Wrinkles, "fishmouths" or other membrane defects occurring at the curb face shall be sealed against water intrusion by using Bituthene Mastic and/or patch strips. Finally, a bead of mastic sealer shall be applied along the entire length of curb face, at the termination edge of the membrane flashing strip.

Flashing strips of membrane shall be applied to the outside faces of headers and scuppers. The strips shall be placed on the vertical faces to the height of the asphalt overlay, and shall extend a minimum of 6 inches on the structural slab. The strips shall be pressed into contact with the vertical surface. If necessary, mastic sealer shall be used to insure adhesion. The preformed membrane sheet shall then be applied on the structural slab as close as possible to the vertical face. Any wrinkles, "fish-mouths" or other defects shall be corrected using mastic sealer and/or patches. A beam of mastic sealer shall be applied to the vertical face at the termination edge of the membrane flashing strip.

The termination edge of the membrane at deck ends and expansion joints constructed without headers shall be sealed with mastic sealer.

At subsurface drains, pieces of membrane flashing strip shall be applied to that area of structural slab within 6 inches of the drain opening. The full preformed membrane shall then be placed over the strips to provide double cover. At the subsurface drain, the pre-formed membrane shall be pierced and the edges turned down and adhered to the inside drain surface. If necessary, mastic sealer shall be used to insure adhesion of the membrane and to prevent the seepage of water under the membrane. Five-inch square pieces of wire mesh shall be pressed into a coat of mastic sealer, applied over the membrane at each subdrainage opening. Payment for wire mesh shall be included in this item.

When only a portion of the work area is completed in one day, the exposed edge of the membrane shall be sealed with mastic sealer.

The completed membrane shall be free of large wrinkles, "fish-mouths," air bubbles and other placement defects. These shall be corrected as directed by and to the satisfaction of the Engineer. When patches are used, the pieces of membrane patch shall be pressed into contact with the membrane sheet. The patch shall extend at least 4 inches in every direction beyond the edge of the defect. The edges of the patch shall be sealed with mastic sealer. Bubbles of one-inch diameter and greater shall be vented by piercing with an ice pick, or other suitable instrument, and expelling the air. Vented bubbles are self-sealing and need not be repaired.

Item Bridge Preformed Membrane Waterproofing System
Page 5

METHOD OF MEASUREMENT:

The work shall be measured as the number of square feet of actual horizontal surface area of the structural slab covered with the complete membrane waterproofing system. No separate measurement of the vertical faces of curbs, headers and scuppers, or for the inside surfaces of subdrainage outlets, shall be made. No measurement shall be made for laps.

BASIS OF PAYMENT:

The unit price bid per square foot for this item, shall include the cost of furnishing all labor, materials (including wire mesh) and equipment necessary to complete the work.

APPENDIX B

SPECIFICATIONS FOR PROTECTO-WRAP M-400A

MEMBRANE WATERPROOFING

ITEM BRIDGE PREFORMED MEMBRANE WATERPROOFING SYSTEM (PROTECTO WRAP M-400A

SCOPE:

This work shall consist of furnishing and applying a preformed membrane waterproofing system. It shall include, but not be limited to, the preparation of concrete surfaces; the application of cold applied primer, and preformed membrane as specified in Contract Documents.

MATERIALS:

The preformed membrane waterproofing system shall be as manufactured by Protecto Wrap Company, Denver, Colorado, and shall consist of the following materials:

Bridge Preformed Membrane - Protecto Wrap M-400A

Primer - Protecto Wrap No. 80 (or 8AP) Primer

Mastic Sealer - Protecto Wrap 160H Mastic

Wire Mesh for use over subdrainage openings, shall be a first class, 1/4-inch mesh by 23 gauge, hot-dipped galvanized cloth.

CONSTRUCTION DETAILS:

A. Preparation of Structural Slab Surfaces.

All structural slab surfaces that are to be waterproofed, including vertical surfaces, shall be prepared and cleaned as follows: Unless otherwise directed by the Engineer, work shall not begin on new structural slabs until a minimum of 28 days after concrete placement.

1. All loose material, including dirt, stones, gravel and concrete laitance shall be removed by vacuuming or blowing with compressed air.

2. Any excess laitance (surface film of concrete), road oil, other bituminous based contaminates, and other foreign materials, including concrete curing compounds, which are detrimental to membrane adhesion shall be removed by sandblasting or wire brushing and washing with water or a combination of these methods. To determine if adhesion problems exist, small test patches of primer and membrane shall be applied to the area(s) in question. These test patches shall then be checked by the Engineer to determine the compatibility and adhesion of the membrane to the concrete surface.

3. All surface projections, including exposed aggregate or any other conditions which have presented so rough a concrete surface, as determined by the Engineer to be detrimental to the membrane, shall be ground smooth, or grouted smooth with cement mortar or epoxy. If grouting materials are used, they shall be "set up" and surface dry, prior to application of primer. Cement mortar mixes for use in grouting shall be approved by the Engineer prior to use. Epoxy mortar materials shall consist of epoxy material meeting the requirements of Material Specifications 721-01, 721-02 or 721-03, and fine aggregate as approved by the Engineer.

4. Immediately prior to primer application, surfaces to be primed shall be re-cleaned of dust and other loose foreign material by vacuuming or blowing with compressed air.

B. Atmospheric Conditions.

Work shall not be done during wet weather conditions nor, when determined by the Engineer atmospheric conditions are such as to produce unsatisfactory results. No work shall be done when the structural slab surface temperature is below 50°F. and ambient temperatures are below 50°F. The concrete structural slab shall be surface dry at the time of primer application.

C. Primer Application.

After cleaning, all concrete surfaces to be waterproofed shall be primed with Protecto Wrap No. 80 Primer. The primer shall be thoroughly mixed, prior to use. Mixing shall be done with mechanical mixers or hand mixed, using clean paddles or other suitable instruments. All settled material shall be thoroughly dispersed.

The primer shall be applied, without dilution, by the use of brushes or rollers, or squeegees or a combination of these methods. Spray application of primer will not be allowed. The primer shall be applied at such a rate as to thoroughly and uniformly cover the concrete surface. Normal application rate of primer is 110 sq-ft/gal, but depending on the porosity and texture of the concrete surface, the application rate may vary from 80 to 150 sq-ft/gal.

On vertical curb and header surfaces, the primer shall be applied and finished off, in a neat line, to a height that will be one inch ± higher than the top of the upturned edge of the preformed membrane overlay. The entire outside face of scuppers shall be primed. The inside surfaces of subdrainage outlets (weep tubes) shall be primed to a depth of at least 3 inches.

The primer shall be allowed to dry to a "tack-free" condition, prior to application of the preformed membrane. This time, which is dependent upon temperature and humidity, is normally 1/2 to 1-1/2 hours. Excess primer, occurring as "puddles" or wet areas, shall be removed by brushes, or as directed by the Engineer.

Primed surfaces which have not been covered with preformed membrane within 24 hours after the application of primer shall be re-primed.

Primed surfaces which, as determined by the Engineer, have become contaminated by dust and dirt shall be re-primed.

The appearance of bubbles in the primer is normal, due to out-gassing of air and moisture in the concrete. After the primer has dried to a "tack-free" condition, these bubbles shall be broken with squeegees or brooms. Unless otherwise directed by the Engineer, it shall not be necessary to repair the areas where bubbles have been broken.

D. Preformed Membrane Installation.

Protecto Wrap M400A Membrane shall be applied to primed surfaces no later than 24 hours after primer application.

Rolls of preformed membrane may be applied by hand or mechanical means. The membrane shall be placed on the structural slab, sticky side down, and shall be turned up the faces of curbs and headers and scuppers to a height equal to the thickness of bituminous overlay. To minimize wrinkles and bubbles, rolls of membrane shall be "stretched" into place and squeegees shall be used, at the time of application, to smooth the membrane at its point of contact with the structural slab.

To minimize damage from foot traffic and rolling operations, the polyethylene release film, except for the perforated edge strip, shall remain in place until just prior to paving the bituminous overlay. The perforated edge strip of polyethylene film shall be removed at the time of placement and alignment of an adjacent roll of membrane. Spliced rolls of membrane have release film on the bottom (sticky side). Care shall be taken to insure removal of the polyethylene film from the spliced areas at the time of membrane application.

To insure adhesion to the structural slab, the preformed membrane shall be rolled with pneumatic tired roller. Rolling shall be done after placement of the membrane or at the end of each day's work, as applicable.

The preformed bridge membrane shall be laid longitudinally on the structural slab, in the direction opposite that of bituminous paving, so that end laps are formed in the direction of bituminous paving. It shall be placed from a low to a high area and in such a manner as to produce a "shingling" effect to drain any water that accumulates toward the curb and scuppers. Adjacent rolls of preformed membrane shall overlap a minimum of 2 inches and a minimum of 8 inches on end laps. If dirt or dust has contaminated exposed edges, primer shall be applied to the contaminated areas to seal the overlaps.

The application of preformed membrane shall commence at the curb section(s). The vertical face of the curb shall be coated with Protecto Wrap 160 H sealer. The mastic sealer shall be applied as a smooth

ITEM BRIDGE PREFORMED MEMBRANE WATERPROOFING SYSTEM
Page 4

uniform coat. The preformed membrane shall be aligned parallel to and be brought up the face of the curb to a height equal to the depth of bituminous overlay. The membrane shall be thoroughly pressed into the mastic sealer. Wrinkles or "fishmouths" or other membrane defects occurring at the curb face shall be sealed against water intrusion by the use of additional mastic sealer and/or patch strips. Finally, a bead of mastic sealer shall be applied along the entire length of curb face, at the termination edge of the membrane.

The outside face of headers and scupper frames shall be coated with mastic sealer. The membrane shall be turned up and pressed into the sealer to the height of the asphalt overlay. Any wrinkles and "fishmouths" shall be sealed with additional mastic sealer and/or patches. A bead of mastic sealer shall be applied at the termination edge of the membrane.

The termination edge of the membrane at deck ends and expansion joints constructed without headers shall be sealed with mastic sealer.

At subsurface drains, mastic sealer shall be applied to the area of structural deck slab within 6 inches of the drain and to the inside surfaces of the drain, to a depth of 3 inches. The membrane shall be pierced at the drain and the edges turned down and pressed into the mastic sealer. Five-inch square pieces of wire mesh shall be pressed into a coat of mastic sealer, applied over the membrane at each subdrainage opening. Payment for wire mesh shall be included in this item.

When only a portion of the work area is completed in one day, the exposed edge of the membrane shall be sealed with mastic sealer.

The completed membrane shall be free of large wrinkles, "fishmouths," air bubbles and other placement defects. These shall be corrected as directed by and to the satisfaction of the Engineer. When patches are used, the area shall be coated with mastic sealer and pieces of membrane pressed into the sealer over the defective area. The patches shall extend at least 6 inches in every direction beyond the edge of the defect. Bubbles of one-inch diameter and greater shall be vented by piercing with an ice pick, or other suitable instrument, and expelling the air. Vented bubbles are self-sealing and need not be repaired.

METHOD OF MEASUREMENT:

The work shall be measured as the number of square feet of actual horizontal surface area of the structural slab covered with the complete membrane waterproofing system. No separate measurement of the vertical faces of curbs, headers and scuppers or for the inside surfaces of subdrainage outlets shall be made. No measurement shall be made for laps.

BASIS OF PAYMENT:

The unit price bid per square foot for this item shall include the cost of furnishing all labor, materials (including wire mesh) and equipment necessary to complete the work.

APPENDIX C

SPECIFICATIONS FOR ROYSTON BRIDGE MEMBRANE NO. 10

ITEM BRIDGE PREFORMED MEMBRANE WATERPROOFING SYSTEM
(ROYSTON BRIDGE MEMBRANE No. 10)

SCOPE:

This work shall consist of furnishing and applying a preformed membrane waterproofing system. It shall include, but not be limited to, the preparation of concrete surfaces; the application of cold applied primer, and preformed membrane as specified in the Contract Documents.

MATERIALS:

The preformed membrane waterproofing system shall be as manufactured by Royston Laboratories, Inc., Pittsburgh, Pennsylvania, and shall consist of the following materials:

Bridge Preformed Membrane - Royston Bridge Membrane No. 10

Primer - Royston Bridge Membrane Primer 713

Mastic Sealer - Royston Roskote A-51 Black Mastic

Wire Mesh for use over subdrainage openings shall be a first class, 1/4-inch mesh by 23 gauge, hot-dipped galvanized cloth.

CONSTRUCTION DETAILS:

A. Preparation of Structural Slab Surfaces.

All structural slab surfaces that are to be waterproofed, including vertical surfaces, shall be prepared and cleaned as follows: Unless otherwise directed by the Engineer, work shall not begin on new structural slabs until a minimum of 28 days after concrete placement.

1. All loose material, including dirt, stones, gravel and concrete laitance shall be removed by vacuuming or blowing with compressed air.

2. Any excess laitance (surface film of concrete), road oil, other bituminous based contaminants, and other foreign materials, including concrete curing compounds, which are detrimental to membrane adhesion shall be removed by sandblasting or wire brushing and washing with water or a combination of these methods. To determine if adhesion problems exist, small test patches of primer and membrane shall be applied to the area(s) in question. These test patches shall then be checked by the Engineer to determine the compatibility and adhesion of the membrane to the concrete surface.

3. All surface projections, including exposed aggregate or any other conditions which have presented so rough a concrete surface, as determined by the Engineer to be detrimental to the membrane,

ITEM BRIDGE PREFORMED MEMBRANE WATERPROOFING SYSTEM
Page 2

shall be ground smooth, or grouted smooth with cement mortar or epoxy. If grouting materials are used, they shall be "set up" and surface dry, prior to application of primer. Cement mortar mixes for use in grouting shall be approved by the Engineer prior to use. Epoxy mortar materials shall consist of epoxy material meeting the requirements of Material Specifications 721-01, 721-02 or 721-03, and fine aggregate as approved by the Engineer.

4. Immediately prior to primer application, surfaces to be primed shall be re-cleaned of dust and other loose foreign material by vacuuming or blowing with compressed air.

B. Atmospheric Conditions.

Work shall not be done during wet weather conditions nor, when determined by the Engineer, atmospheric conditions are such as to produce unsatisfactory results. No work shall be done when the structural slab surface temperature is below 50°F and ambient temperatures are below 50°F. The concrete structural slab shall be surface dry at the time of primer application.

C. Primer Application.

After cleaning, all concrete surfaces to be waterproofed shall be primed with Royston Bridge Membrane Primer 713. The primer shall be thoroughly mixed prior to use.

Mixing shall be done by hand only, using clean paddles or other suitable instruments.

The primer shall be applied, without dilution, by the use of brushes or rollers or squeegees or a combination of these methods. Spray application of primer shall not be allowed. The primer shall be applied at an average rate of 90 square feet per gallon and in such a manner as to thoroughly and uniformly cover the concrete surface.

On vertical curb and header surfaces, the primer shall be applied and finished off, in a neat line, to a height that will be one inch ± higher than the upturned edge of the preformed membrane overlay. The entire outside face of scuppers shall be primed. The inside surfaces of subdrainage outlets (weep tubes) shall be primed to a depth of at least 3 inches.

The primer shall be thoroughly dry prior to application of the preformed membrane. Drying time, which is dependent upon temperature and humidity is normally one-half hour. Excess primer, occurring as "puddles" or wet areas, shall be removed by brushes, or as directed by the Engineer.

Primed surfaces which have not been covered with preformed membrane within 24 hours after the application of primer, shall be re-primed.

Primed surfaces which, as determined by the Engineer, have become contaminated by dust and dirt shall be re-primed.

The appearance of bubbles in the primer is normal, due to out-gassing of air and moisture in the concrete. After the primer has dried to a "tack-free" condition, these bubbles shall be broken with squeegees or brooms. Unless otherwise directed by the Engineer, it shall not be necessary to repair the areas where bubbles have been broken.

D. Preformed Membrane Installation.

Royston Bridge Membrane No. 10 shall be applied to primed surfaces no later than 24 hours after primer application.

Rolls of membrane may be applied by hand or mechanical means. The membrane shall be placed on the structural slab sticky side down, by removing the release paper as the work progresses. The preformed membrane shall be turned up the faces of curbs and headers and scuppers to a height equal to the thickness of bituminous overlay. The membrane shall be placed in such a manner as to minimize wrinkles and bubbles but shall not be stretched or otherwise placed in tension. Squeegees shall be used, at the time of application, to smooth the membrane at its point of contact with the structural slab.

To insure adhesion to the structural slab, the preformed membrane shall be hand-rolled with a 100-200 pound roller. Rolling shall be done after placement of the membrane on the structural slab surface or at the end of each day's work, as applicable.

The preformed bridge membrane shall be laid longitudinally on the structural slab in the direction opposite to that of bituminous paving so that end laps are formed in the direction of bituminous paving. It shall be placed from a low to a high area and in such a manner as to produce a "shingling" effect to drain any water that accumulates toward the curb and scuppers. Adjacent rolls of preformed membrane shall overlap a minimum of 2 inches and 8 inches on end laps. The narrow band of release paper which acts as an edge strip shall be removed from an applied roll to expose the sticky edge and to insure bonding with the underside of an adjacent roll and sealing of the lap. End laps shall be sealed by heating the membrane surface to be covered with a propane torch, melting the polyester film and fusing the applied surface to the underside of the covering roll.

The application of preformed membrane shall commence at the curb section(s). The preformed membrane shall be aligned parallel to and be brought up the face of the curb to a height equal to the depth of bituminous overlay. The up-turned portion of membrane shall be bonded to the curb face by the heat fusion method; by heating the sticky side of the membrane with a propane torch and pressing the heated membrane into contact with the curb face. Wrinkles or "fishmouths" or other

ITEM BRIDGE PREFORMED MEMBRANE WATERPROOFING SYSTEM
Page 4

membrane defects occurring at the curb face shall be sealed against water intrusion by using mastic sealer (Royston Roskote A-41 Black Mastic) and/or patch strips. Finally, a bead of mastic sealer shall be applied along the entire length of curb face, at the termination edge of the membrane.

The membrane shall be turned up the outside face of headers and scupper frames to the height of the asphalt overlay. The membrane shall be adhered to these surfaces by the heat-fusion method. Any wrinkles and "fishmouths" shall be sealed, using mastic sealer and/or patches. A bead of mastic sealer shall be applied at the termination edge of the membrane.

The termination edge of the membrane at deck ends and expansion joints constructed without headers shall be sealed with mastic sealer.

At subsurface drains, the membrane shall be pierced and the edges turned down and adhered to the inside drain surface by the heat-fusion method. If necessary, mastic sealer shall be applied to insure adhesion of the membrane and to prevent the seepage of water under the membrane. Five-inch square pieces of wire mesh shall be pressed into a coat of mastic sealer, applied over the membrane at each subdrainage opening. Payment for wire mesh shall be included in this item.

When only a portion of the work area is completed in one day, the exposed edge of the membrane shall be sealed with mastic sealer.

The completed membrane shall be free of large wrinkles, "fishmouths," air bubbles and other placement defects. These shall be corrected as directed by and to the satisfaction of the Engineer. When patches are used, the pieces of membrane patch shall be affixed by the heat-fusion method and pressed into contact with the membrane sheet. The patch shall extend at least 4 inches in every direction beyond the edge of the defect. The edges of the patch shall be sealed with mastic sealer. Bubbles of one inch diameter and greater shall be vented by piercing with an ice pick, or other suitable instrument, and expelling the air. Vented bubbles are self-sealing and need not be repaired.

METHOD OF MEASUREMENT:

The work shall be measured as the number of square feet of actual horizontal surface area of the structural slab covered with the complete membrane waterproofing system. No separate measurement for the vertical faces of curbs, headers and scuppers or for the inside surfaces of subdrainage outlets shall be made. No measurement shall be made for laps.

BASIS OF PAYMENT:

The unit price bid per square foot for this item shall include the cost of furnishing all labor, materials (including wire mesh) and equipment necessary to complete the work.

APPENDIX D

SPECIFICATIONS FOR NEA-4000 LT MEMBRANE WATERPROOFING

ITEM - BRIDGE MEMBRANE WATERPROOFING SYSTEM
(PVC POLYMER, LT)

DESCRIPTION: This work shall consist of furnishing and applying a liquid, poly-vinyl chloride polymer waterproofing system. It shall include the preparation of concrete surfaces; the application of one coat of hot applied PVC polymer waterproofing and protective sheet as shown on the Contract Plans.

MATERIALS: The bridge membrane waterproofing system shall consist of the following materials:

PVC Polymer Waterproofing - Liquid polymer waterproofing material shall be one of the following:

1. NEA-4000 LT, as manufactured by POSH Chemical, Inc., Port Washington, N.Y.

or

2. Superseal-4000 LT, as manufactured by Superior Products Co., Oakland, CA.

or

3. WABO-4000 LT, as manufactured by Watson-Bowman Assoc., Inc., Buffalo, N.Y.

Protective Sheet - 65-lb. asphalt roofing paper, meeting the requirements of ASTM D-224, 65-lb. Grade.

Wire Mesh - for use over subdrainage openings shall be a ½ inch mesh by 23 gauge, hot dipped galvanized cloth.

Note: Containers of PVC polymer waterproofing material shall be stored on the work site in such a manner as to prevent their exposure to direct sunlight and to temperatures exceeding 100°F.

CONSTRUCTION DETAILS:

A. Preparation of Concrete Structural Slab Surfaces:

Work shall not begin on new structural slabs until a minimum of 7 days after concrete placement.

All structural slab surfaces designated to receive liquid waterproofing materials, including vertical surfaces shall be prepared and cleaned as follows:

1. All loose material, including dirt, stones and gravel shall first be removed by vacuuming or blowing with compressed air.

2. The entire structural slab surface shall be sandblasted. Sandblast operations shall be done to the extent that excess laitance (surface film of concrete mortar), road oil, other bituminous based contaminants and foreign materials, including concrete during compounds and previous membrane treatments are removed. If necessary the blasting operation shall be supplemented by wire brushing or washing with water. At the completion of sandblasting operations, all blasting residue shall be removed by vacuuming or blowing with compressed air.

3. All surface projections, including exposed aggregate and other protrusions greater than ¼ inch in height shall be ground smooth or grouted smooth with cement or epoxy mortar. Sharp concrete edges shall be ground smooth. Potholes and spalled areas shall be patched with cement or epoxy mortar. Patching and grinding operations shall be done to the extent that the surface roughness of the structural slab does not exceed ¼ inch per foot. If grouting materials are used they shall be cured and surface dry prior to the application of PVC waterproofing material. Cement mortar mixes for use in grouting shall be approved by the Engineer prior to use. Epoxy mortar materials shall consist of epoxy material meeting the requirements of Material Specification 721-01, 721-02, or 721-03, and dry fine aggregate as approved by the Engineer.

4. If necessary, immediately preceding the application of the PVC waterproofing, surfaces to be waterproofed shall be re-cleaned of dust and other loose foreign material that may have accumulated, by vacuuming or blowing with compressed air.

B. Atmospheric Conditions:

Work shall not be done during wet weather conditions nor, when atmospheric conditions are such that unsatisfactory results will be produced. The Engineer shall be the sole determinant of favorable atmospheric conditions. No work shall be done when the concrete structural slab surface temperature is below 40°F or ambient temperatures are below 40°F. The concrete structural slab shall be surface dry at the time of application of the PVC waterproofing material.

C. Application of PVC Polymer Waterproofing Material:

After cleaning operations have been completed, surfaces to be waterproofed shall be coated with one coat of PVC polymer waterproofing material. The PVC waterproofing shall be hot applied at a minimum rate of 17.8 square feet per gallon (minimum wet film thickness of 90 mils) and at a temperature of from 275°F to 300°F. All concrete structural slab surfaces shall be surface dry at the time of application of waterproofing material.

The PVC waterproofing material, as supplied in its container, is ready for pouring into the heating vessel. The heating vessel shall be double-boiler, indirect-fired or oil-bath melter-applicator type kettle. Heating with direct flame shall not be allowed. Heating equipment shall be inspected and approved by the Engineer prior to use. When the application temperature (275-300°F) has been attained, the hot polymer material shall be poured directly onto the structural slab and spread at the specified application rate, using squeegees. Brushes and rollers may be used to supplement the squeegee operation.

The vertical faces of curbs, headers and scuppers shall be coated with hot PVC waterproofing and finished off in a neat line, to a height that will be at least 1 inch higher than the height of bituminous overlay. If necessary on the vertical face multi-coat applications shall be made to obtain the required film thickness (90 mils, min.).

The inside surfaces of sub-drainage outlets (weep tubes) shall be coated with hot PVC waterproofing to a depth of at least 1 inch. Immediately after placement of the waterproofing material, 5-inch square pieces of wire mesh shall be pressed into the wet coat of PVC over each sub-drainage opening.

The completed coat of waterproofing shall be free of large pinholes, craters and other placement defects. Pinholes and craters of 1/8 inch diameter and greater shall be corrected by "touching" up with hot PVC material or sealing with pre-cured pieces of PVC waterproofing. Pre-cured patch material is made by applying hot liquid PVC to a smooth, impervious surface (the lid or top of the PVC container is suitable) and allowing it to cure in a sheet form. Pieces of this sticky sheet may then be used to plug holes or patch the PVC membrane. Defects in the waterproofing of less than 1/8" diameter are self-sealing and shall not require repair.

Throughout the duration of work the Contractor shall protect all exposed areas of curbs, sidewalks, railings and other bridge appurtenances. Any damage or defacement resulting from the application of the PVC waterproofing shall be repaired to the satisfaction of the Engineer, at no cost to the State.

D. Application of Protective Sheet:

The protective sheet (65 lb. roofing paper) shall be placed over the PVC polymer waterproofing immediately after completion of the liquid waterproofing application, or a portion thereof, as directed by the Engineer.

The 65-lb. roofing paper shall be placed over all of the structural slab surface, except that it shall not be placed on the vertical faces of curbs, or headers or scuppers. At sub-drainage outlets, holes equal in size to

the outlet opening shall be cut in the roofing paper. The roofing shall not be placed in, or otherwise adhered to the inside surfaces of sub-drainage outlets.

The protective sheet shall be laid flat, without the necessity of adhesives, on the cured surface of PVC waterproofing. (Hot applied liquid PVC polymer waterproofing material will cure to a firm film within several minutes. The surface of the cured PVC will remain in a tacky or sticky condtion. The 65# roofing paper is to be applied directly to the sticky surface.) Rolls or sections of 65-lb. roofing paper shall be set in place by butting against the edges and ends of adjacent sheets. Gaps of up to ¼ inch between sheets are allowable. Overlapping of the protection sheet shall not be allowed.

The completed protection sheet shall be free of wrinkles, "fishmouths," entrapped air bubbles and other defects. Wrinkles and "fishmouths" shall be slit with a knife and laid flat. Entrapped air shall be removed by piercing the roofing paper with an ice pick or other suitable instrument. Care shall be taken not to puncture the underlying PVC membrane.

When the placement defects have been corrected, the entire surface of roofing paper shall be rolled with a 100-200 pound hand roller. If, after rolling, additional air bubbles or other defects are evident they shall be corrected.

Finally, when the placement and rolling of the roofing paper is complete, a bead of hot PVC polymer material shall be run along the intersection where the vertical faces of curbs, headers and scuppers meet the roofing paper. The bead shall be placed such that the void between the roofing paper and applied membrane is filled with polymer to prevent the intrusion of water.

METHOD OF MEASUREMENT:

The work shall be measured as the number of square feet of actual horizontal surface area of the structural slab covered with the complete membrane waterproofing system. No separate measurement of the vertical faces of curbs, headers and scuppers or for the inside surfaces of sub-drainage outlets shall be made.

BASIS OF PAYMENT:

The unit price bid per square foot for this item shall include the cost of furnishing all labor, materials (including wire mesh) and equipment necessary to complete the work.

APPENDIX E

		Page
1.	SPECIFICATIONS FOR BITUMINOUS EPOXY MEMBRANE WATERPROOFING	51-54
2.	MATERIAL SPECIFICATION 717-02: BITUMINOUS EPOXY PROTECTIVE COATING	55-56

ITEM - BRIDGE BITUMINOUS EPOXY MEMBRANE WATERPROOFING SYSTEM (TWO COAT APPLICATION).

DESCRIPTION: This work shall consist of furnishing and applying a bituminous epoxy waterproofing system. It shall include the preparation of concrete surfaces; the application of two coats of bituminous epoxy protective coating and the application of coarse aggregate as shown on the contract plans.

MATERIALS: The bituminous epoxy membrane waterproofing system shall consist of materials meeting the requirements of the following subsections of Section 700 - Materials.

Bituminous Epoxy Protective Coating	717-02
Coarse Aggregate	703-02

Wire mesh, for use over sub-drainage openings, shall be a ¼" mesh by 23 gauge, hot dipped galvanized cloth.

CONSTRUCTION DETAILS:

A. Preparation of Concrete Structural Slab Surfaces:

Work shall not begin on new structural slabs until a minimum of 7 days after concrete placement.

All structural slab surfaces to be waterproofed, including vertical surfaces shall be prepared and cleaned as follows:

1. All loose material, including dirt, stones, gravel and concrete laitance shall be first removed by vacuuming or blowing with compressed air.

2. The entire structural slab surface shall be sandblasted. Sandblast operations shall be done to the extent that excess laitance (surface film of concrete mortar), road oil, other bituminous based contaminants and other foreign materials, including concrete curing compounds and previous membrane treatments are removed. If necessary, the blasting operation shall be supplemented by wire brushing or washing with water. At the completion of sandblasting operations, all blasting residue shall be removed by vacuuming or blowing with compressed air.

3. All surface projections, including exposed aggregate and other protrusions greater than ¼ inch in height shall be ground smooth or grouted smooth with cement or epoxy mortar. Sharp concrete edges shall be ground smooth. Potholes and spalled areas shall be patched with cement or epoxy mortar. Patching and grinding operations shall be done to the extent that the surface roughness of the structural slab does not exceed ¼ inch per foot. If grouting materials are used they shall be cured and surface dry prior to the application of bituminous epoxy protective coating. Cement mortar mixes for use in grouting shall be approved by the Engineer prior to use. Epoxy mortar materials shall consist of epoxy material meeting the requirements of Material Specification 717-02, 721-01, 721-02, or 721-03,

and dry fine aggregate as approved by the Engineer.

4. If necessary, immediately preceding the application of bituminous epoxy protective coating, surfaces to be waterproofed shall be re-cleaned of dust and other loose foreign material that may have accumulated by vacuuming or blowing with compressed air.

B. Atmospheric Conditions:

Work shall not be done during wet weather conditions nor when atmospheric conditions are such that unsatisfactory results will be produced. The Engineer shall be the sole determinate of favorable atmospheric conditions. No work shall be done when the concrete structural slab surface temperature is below 50°F or ambient temperatures are below 50°F or when the relative humidity is greater than 85%. The concrete structural slab shall be surface dry at the time of application of bituminous epoxy protective coating.

C. Application of Bituminous Epoxy Membrane Waterproofing System:

After cleaning operations have been completed, surfaces to be waterproofed shall be covered with two coats of bituminous epoxy protective coating and one application of coarse aggregate.

Concrete structural slab or previously coated surfaces shall be surface dry at the time of application of bituminous epoxy protective coating.

If necessary, the Contractor shall protect uncured coats of bituminous epoxy protective coating against rain or other detrimental elements. Protection shall be provided for the time period required for the bituminous epoxy to field cure.

For purposes of this specification, field cure is determined as the time required for the bituminous epoxy to cure to a firm, hard state, such that no movement of the film or damage occurs due to foot traffic.

Each coat of bituminous epoxy protective coating shall be applied at the rate of 30-35 square feet per gallon. The bituminous epoxy shall be thoroughly mixed prior to use. Mixing shall be done with mechanical mixers or hand mixed, using clean paddles or other suitable instruments. Care shall be taken to minimize the introduction of air bubbles in the epoxy during mixing. The bituminous epoxy shall be applied without dilution. The first coat shall be applied and thoroughly worked into the structural slab surface by the use of brushes or rollers or squeeges or a combination of these methods. Spray application of the first coat of bituminous epoxy shall not be allowed. The second coat may be applied by airless spray or any of the preceding methods.

The first coat of bituminous epoxy shall be applied and allowed to obtain a field cure prior to the application of the second coat. Coarse aggregate

shall not be spread in the first coat. The appearance of bubbles in the bituminous epoxy is normal, due to out-gassing of air and moisture in the concrete. When the field cure has been obtained, bubbles in the first coat shall be broken as much as possible with squeeges or brooms. Unless otherwise directed by the Engineer, it shall not be necessary to repair the areas where bubbles have been broken.

The second coat of bituminous epoxy shall be placed as soon as possible after the first coat has field-cured. In any event the second coat shall be applied within 12 hours after placement of the first coat. If the second coat has not been applied within the 12-hour time period the dried surface of the first coat shall be roughed-up by sandblasting (brush-off blasting) and the sandblasting residue removed. Sandblasting and cleaning shall be at the Contractor's expense. Coarse aggregate shall be applied immediately after the application of the second coat of bituminous epoxy. The aggregate shall be spread while the epoxy surface is still wet and before any substantial degree of cure has been obtained. The primary size of coarse aggregate shall be No. 1, except that material passing the No. 200 sieve shall not exceed 0.5%. The coarse aggregate shall be surface dry and shall be spread on the wet bituminous surface at a rate of between 6 to 9 pounds per square yard (0.67 to 1.0 lbs. per square ft.). The pictorial standards of the Materials Bureau shall be used to visually define the application rate of aggregate.

The vertical faces of curbs, headers and scuppers shall be coated with two coats of bituminous epoxy and finished off in a neat line, to a height that will be at least 1 inch higher than the height of bituminous overlay. To seal the interface, if vertical faces are coated before or after the general application of a coat of bituminous epoxy on the horizontal deck, the coating shall extend down the vertical face and onto the horizontal structural slab or bituminous membrane for a minimum of 2 inches, as applicable. Coarse aggregate shall not be applied to vertical surfaces.

The inside surfaces of sub-drainage outlets (weep tubes) shall be coated with two coats of bituminous epoxy to a depth of at least 1 inch. Immediately after placement of the second coat, 5-inch square pieces of wire mesh shall be pressed into the wet epoxy over each sub-drainage opening. The wire mesh shall be placed before the coarse aggregate is spread on the second coat of bituminous epoxy. Coarse aggregate shall not be applied to the inside surfaces of sub-drainage outlets.

The completed membrane waterproofing system shall be free of large air bubbles and other placement defects. These shall be corrected as directed by and to the satisfaction of the Engineer. Bubbles of 1 inch diameter and greater shall be vented by piercing with an ice pick or other suitable instrument and expelling the air. Vented bubbles in the second coat of bituminous epoxy shall be sealed against water intrusion by "touching-up" with bituminous epoxy.

Throughout the duration of work the Contractor shall protect all exposed areas

of curbs, sidewalks, railings and other bridge appurtances. Any damage or defacement resulting from the application of the membrane system shall be repaired to the satisfaction of the Engineer, at no cost to the State.

METHOD OF MEASUREMENT:

The work shall be measured as the number of square feet of actual horizontal surface area covered with the complete membrane waterproofing system. No separate measurement for the vertical faces of curbs, headers and scuppers or the inside surfaces of sub-drainage outlets shall be made.

BASIS OF PAYMENT:

The unit price bid per square foot for this item, shall include the cost of furnishing all labor, materials (including wire mesh) and equipment necessary to complete the work.

717-02 BITUMINOUS EPOXY PROTECTIVE COATING

SCOPE. This specification covers the material requirements of a flexible bituminous epoxy protective coating system. This material is used as a protective membrane on Portland cement concrete structural decks with bituminous concrete wearing courses, and with aggregate as a mortar to repair structural decks which are to receive the protective membrane. This material should not be applied at temperatures below 50°F.

GENERAL. The bituminous epoxy protective coating system shall be a one coat, two component (1:1 ratio by volume), flexibilized, thermo-setting system consisting of a modified epoxy resin, Component A, and a curing agent, Component B.

MATERIAL REQUIREMENTS.

Characteristics of Component A. Component A shall consist of a modified epoxy resin, free of contaminants and shall exhibit the following characteristics.

Property	ASTM Test Method	Requirements Min.	Max.
Viscosity at 75±2°F,cps.	-	-	3000
Epoxide Equivalent	D-1652	225	265
Ash Content, % by Weight	D-482	-	0.2
Volatile Content, mls, distillate	D-1078	-	3.0

Characteristics of Component B. Component B shall be the curing agent for the modified epoxy resin (Component A) and shall consist of a bitumen which has been especially treated with a modified aliphatic polyamine to produce the required properties. It shall exhibit the following characteristics:

Property	ASTM Test Method	Requirements Min.	Max.
Viscosity at 75±2°F,cps.	-	400	1100
Ash Content, % by Weight	D-482	-	0.5
Volatile Content, mls distillate, below 350°F.	D-1078	-	3.0

Pot Life and Cure Requirements. A mixture of Components A and B, prepared in the ratio of 1:1 by volume, shall exhibit the following characteristics:

Property	ASTM Test Method	Requirements Min.	Max.
Color	-	Black	-
Pot Life, minutes	-	10	45
Shore "D" Hardness at 75±2°F., points	D-2240	35/10	55/10

The chemical composition of the mixed components shall be so controlled that cure of a 70 mil thick film when applied to a concrete deck will be accomplished within the time and under the conditions indicated below:

Ambient Air and Deck Temperature, °F	Maximum Cure Time, Hrs. Night	Day
50	6	5
70	5	4
90	3	2.5

Cured Properties of Test Casting. A test casting of Components A and B in the ratio of 1:1 by volume shall be prepared in a mold open to the atmosphere on the top surface. The thickness of the casting shall be 1/8"±1/32". The casting shall be allowed to cure for 7 days at 75±2°F and 50% relative humidity. The casting may be removed from the cell after 24 hours. Completely cured casting shall exhibit the following characteristics:

Property	ASTM Test Method	Requirements Min.	Max.
Water Absorption 7 days immersion at 75±2°F, % by wt.	D-570 (2" disc)	-	0.6
Tensile Strength at 75±2°F, ("C" die, as in ASTM D-412, except that the thickness shall be 1/8"±1/32".), psi	D-638 test rate 0.2in/min.	500	-
Tensile Elongation at 75±2°F percent	D-638	50	-

RECEIVED
MAY 23 1977
N.Y.S. D. of T.
ENGR. RES. & DEV.

01530
LRI